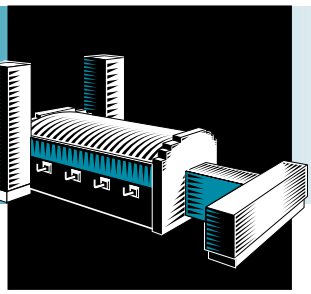
GLASS
Project Fact Sheet



High-Throughput Vacuum Processing for Innovative Uses of Glass

Benefits

- Could save 2100 Btu of electricity per installation annually
- Could save 0.2 billion Btu annually by 2010
- Could eliminate 500 gallons per day of cadmium-contaminated wastewater with each installation
- Reduces energy required to produce photovoltaics
- Eliminates hazardous waste and effluent treatment systems
- Reduces processing time by more than half
- Provides superior film-thickness uniformity
- Eliminates dust, oxidation, and pinhole problems in film coating
- Decreases equipment needs

Applications

The high-throughput technology seeks to fill the PV industry's critical need to meet the 25% annual increase in manufacturing demand for PV. The process produces thin-film CdTe glass substrates that have the highest long-term potential for low-cost fabrication of solar cells. AVA and heated-pocket deposition technologies present many marketing opportunities for a broad range of products, including many that use glass substrates.

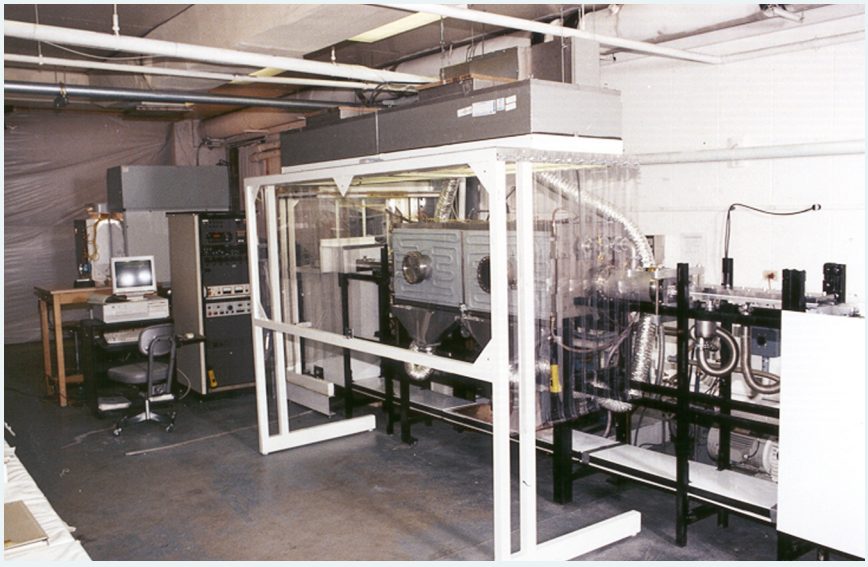
Innovations Increase Energy Savings and Processing Efficiency in Glass Fabrication

Currently, 85% to 90% of the world's photovoltaic (PV) products are made from crystalline silicon (c-Si). However, the availability of the prevalent feedstock material for c-Si is limited and is increasing in cost. In addition, the energy payback time for c-Si is up to 15 years, while the typical module's life is only 20 years.

In an effort to overcome the shortage and cost limitations of c-Si, a new technology is being developed using cadmium telluride (CdTe). CdTe is a thin-film material where layers of the semiconductor are deposited on a substrate, most frequently glass, in a vacuum environment. CdTe PV uses up to 100 times less semiconductor material than c-Si and does not suffer the c-Si feedstock limitations.

A new technology, high-throughput vacuum processing, uses an air-to-vacuum-to-air (AVA) continuous-belt transport, a unique large-area vapor source for coating, and large-area glass substrate heaters for producing PV modules of CdTe on glass substrates. This process can be used to manufacture a broad range of glass products, especially PV, to save energy and increase the overall processing capability.

Prototype PV Production Equipment



This new technology, developed by members of AVA Technologies, Inc., uses high-throughput vacuum processing to effciently produce CdTe PV on glass substrates.

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Project Description

Goal: Demonstrate an AVA transport-belt system with heated-pocket deposition sources and glass-substrate heaters of high thermal uniformity; demonstrate this in seven processing stations using a vacuum chamber for processing 1' X 1' glass substrates.

The AVA system uses a continuous-belt conveyor to transport the glass substrates from air to vacuum and then back to air. Heated-pocket deposition is a proprietary vapor-source technology for efficient deposition of metals or compounds in vacuums with a high degree of film uniformity. A unique substrate-heating technology allows rapid heating of substrates in vacuum to a high temperature with excellent thermal uniformity without inducing thermal stresses. Substrate-temperature uniformity is critical in achieving film-thickness uniformity and properties.

The system allows complete thin-film devices to be processed without exposing partially completed devices to air, which can lead to formation of undesirable interlayer oxides. The system allows all processing steps to be performed in one vacuum chamber without breaking vacuum, improving throughput, film quality, device efficiency, device stability, and yield, while avoiding pinhole formation. Using this technology, 12.4% efficient devices have been produced and verified by the National Renewable Energy Laboratory.

AVA Technologies, Inc., in collaboration with Colorado State University, is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the U.S. Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Design a prototype on AutoCAD 2000.
- Analyze thermal uniformity at each station using computer simulation (FEM Analysis).
- Assemble, test, and optimize a prototype system.
- Test and experiment for film deposition uniformity and optical properties.
- Analyze data to determine capability of producing large-area devices.

Economics and Commercial Potential

World PV production capacity is over 200 MW per year, with an estimated worth of over $2 billion. For the last 3 years, PV shipments have increased 25% annually, a rate the PV and utilities industries expect to continue. To meet demand, production will have to increase 15-fold from its current level in a decade. Despite the potential for explosive market conditions, the industry's ability to meet anticipated demand is severely restricted by the shortage of feedstock materials, current production capacity, and the difficulty in adding new capacity.

In contrast, the high-throughput vacuum processing technology is well-suited for use in a rapidly expanding market scenario. A manufacturable structure and composition for the CdTe solar cell device have already been developed, and the production process has been optimized. This technology could save 2100 Btu of electricity per installed unit each year. First sales of the technology are expected by 2003. Based on a 10% market penetration by 2010, annual savings could be 0.2 billion Btu with 400 units installed. Market penetration of 30% by 2020 could save 0.9 billion Btu annually from the operation of 1700 units.

Industry of the Future—Glass

In April 1996, several organizations representing the glass industry signed a compact with the Department of Energy (DOE) in an effort to encourage technological innovations that will reduce energy consumption, pollution, and production costs in the industry. The glass industry published a report entitled ***Glass: A Clear Vision for a Bright Future,*** *which articulated the industry's vision of its future. This compact set the foundation for collaborative efforts between the industry and the Federal government. Signed by both key industry players and Department of Energy officials, it was a formal commitment to align DOE'S limited resources to meet the challenges identified in the vision.*

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The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

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